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APPLICATION NUMBER: ***60/479,541***
FILING DATE: ***June 17, 2003***
RELATED PCT APPLICATION NUMBER: *PCT/US04/19271*

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06/17/03 U.S. PTO

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6-19-3 APPROV

Docket Number: 5276-110P

17537 U.S. PTO 60/479541

PROVISIONAL APPLICATION FOR PATENT COVER SHEET (Small Entity)

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53 (c).

INVENTOR(S)/APPLICANT(S)		
Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)
Andrew C.	Kular	10 Pulaski Avenue Riverside, NJ 08075 US

☐ *Additional inventors are being named on page 2 attached hereto*

TITLE OF THE INVENTION (280 characters max)

A TWO STAGE ENERGY STORAGE DEVICE

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ENCLOSED APPLICATION PARTS *(check all that apply)*

☒	Specification	*Number of Pages*	11	☒ Small Entity Statement	
☐	Drawing(s)	*Number of Sheets*		☒ Other (specify)	Acknowledgement Post Card; Express Mail Certificate

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Respectfully submitted,

SIGNATURE [signature] Date 6/17/03

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Title: A TWO STAGE ENERGY STORAGE DEVICE

Inventor: Andrew C. Kular

Type of Documents:

1. Provisional Patent Application Transmittal Letter (x2) - 1 page
2. Our check for $80 to cover the Filing Fee
3. Provisional Patent Application – 11 pages
4. Verified Statement Claiming Small Entity – 2 pages
5. Express Mail Certificate – 1 page
6. Acknowledgement Post Card – 1 page

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(Typed or printed name of person mailing paper or fee)

(Signature of person mailing paper of fee)

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REFERENCES

Patent: US3921049: Charging circuit for battery-operated devices powered by solar cells
Inventor: Mellors, Geoffrey W.; Strongsville, OH
Published / Filed: 1975-11-18 / 1973-09-25

Patent: US5635816: Method and apparatus for controlling battery-charging current
Inventor: Welsh, Daniel; Solana Beach, CA
Gerken, Kenneth F.; Brookeville, MD
Published / Filed: 1997-06-03 / 1995-08-01

Patent: US6339311: Photovoltaic power source for portable electronic device
Inventor: Caldwell, Barry E.; Heston, KS
Published / Filed: 2002-01-15 / 2000-11-15

Patent: US6367259: Battery-less solar power system
Inventor: Timm, Miguel A.; Spring, TX 77388-5721
Published / Filed: 2002-04-09 / 2000-02-15

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FIELD OF INVENTION

This invention relates to electronic power management and storage devices.

BACKGROUND OF THE INVENTION

Portable electronic and electrical devices (PEDs) require lightweight and compact power sources, and while some very low power devices (e.g. calculators) can be powered directly from energy sources such as photovoltaic cells (PV), for many practical PEDs a higher capacity energy storage device such as an electro-chemical battery (battery) is required. Many PEDs employ rechargeable batteries as a means for storing energy during the recharging process and then release the stored energy while the PED is in use.

As is well known to those skilled in the art, electro-chemical batteries have specific requirements for safe and efficient charging. These specific requirements vary by the specific battery technology but in all cases, safe and efficient charging requires applying energy within specific voltage and current levels for specific periods of time. For this reason, the typical energy source employed for charging batteries is generally from stationary and much larger source of energy such as, for example, electric utility mains power or an automobile battery.

The need to have access to a large power source at a fixed stationary location is often not convenient since the very nature of a PED is that the PED is portable and often in use some distance away from a large stationary source of power to recharge the battery. As is also well known to those skilled in the art, there are many potential sources of energy that might be employed to recharge a battery however many of these alternatives to large fixed sources of energy are often of an intermittent nature and may

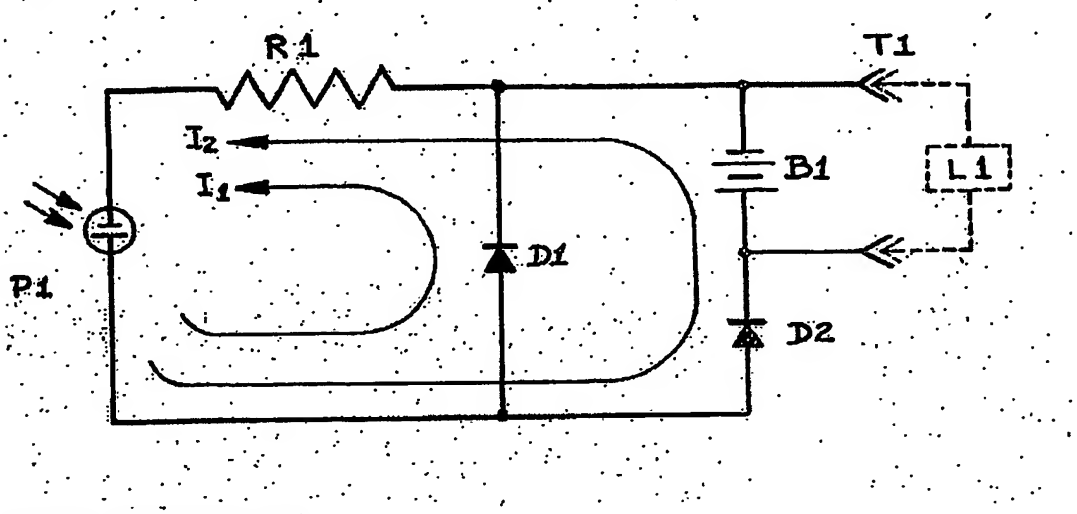
be of too low a level of power to be transformed by conventional methods to suit the specific voltage and current levels needed to safely and efficiently charge a battery. Examples of such potential alternative sources of energy are photovoltaic cells, manually operated electro-magnetic mechanical generators, and brief connections to electric power utility mains while briefly pausing near such mains.

It is the objective to this invention to provide the means for the efficient capture and accumulation of such potential alternative intermittent and variable sources of energy until there is sufficient energy accumulated in a 1st stage energy storage device so that it then be properly conditioned and transformed so that it can be efficiently employed to recharge a 2nd stage of energy storage such as a rechargeable electro-chemical battery.

PRIOR ART

Simple means to recharge an electro-chemical battery using intermittent and variable sources such as photovoltaic cells are well known. For example, Mellors49 employs the circuit of figure 1 for this purpose.

Figure 1 Simple System Employing PV to Recharge a Battery

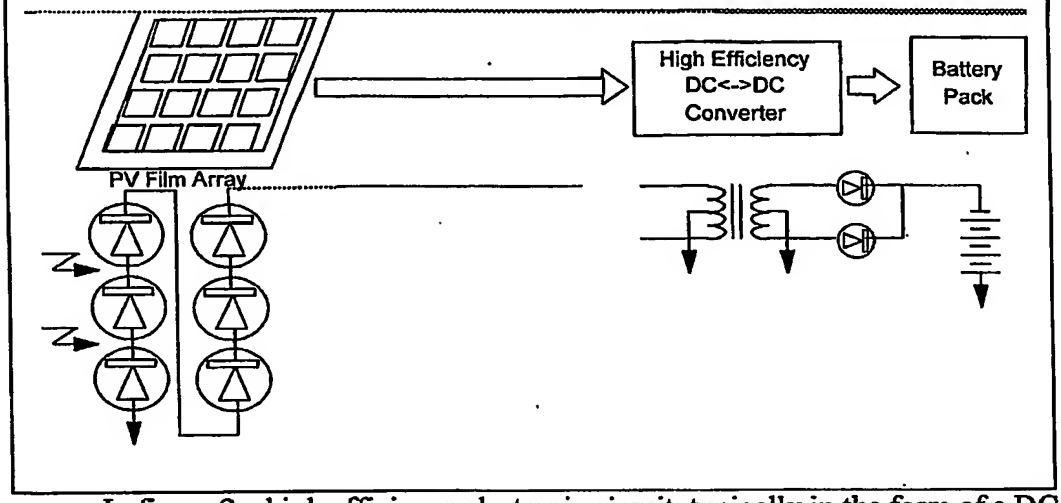


Source: after Mellors49

In the system of figure 1, the battery can only be effectively charged when there is sufficient light intensity such that the voltage output from the PV cell exceeds the battery voltage plus the forward biased diode threshold of device D2. In this case, any energy generated by the PV that is below voltage and current threshold is wasted since it cannot charge the battery B1.

A further problem with the approach of figure 1 is that some modern battery technologies such as Li-Ion cannot be safety charged without charge management electronics to limit voltage and current levels into the battery B1. Such charge management electronics may have even more demanding voltage and current levels than charging the battery directly. For this reason it is not uncommon to employ charge management electronics between the PV cell and the battery. This approach is described, for example, in Welsh16 and shown in simplified form in figure 2.

Figure 2 Improved PV Charging Using Charge Management Electronics



In figure 2 a high efficiency electronic circuit, typically in the form of a DC to DC converter and associated regulation and sensing circuitry is used to convert the DC voltage from the array of PV cells to a voltage more suitable than a direct connection between the PV cells and the battery as in figure 1.

While the approach in figure 2 is an improvement over that of figure 1, it still suffers from the inability to effectively make use of low levels or brief periods of illumination for two related reasons: 1) If the level of illumination is of a low level the voltage generated by the PV cell will not be sufficient to operate the DC to DC converter as any practical electronic device requires voltages well above zero to operate with an efficiency. And 2) If there are very high levels of illumination for a brief period, the PV cells might produce more energy than the batteries can safety absorb during the brief period of illumination. In this case the excess energy generated by the PV cells will be wasted since it cannot be captured and stored in the battery.

Timm 59 recognizes the value of capturing variable and intermittent energy such as from a PV cell source and accumulates this energy in a 1st stage of energy storage. However, Timm59 employs the stored energy to operate a device directly and unlike the

present invention makes no attempt to transfer the 1st stage soft energy storage to a 2nd stage of hard storage such as an electro-chemical battery.

SUMMARY OF THE INVENTION

According to the present invention, an intermediate, or 1st stage of energy storage is inserted between the variable and intermittent energy source and the battery charge management electronics, which connects to the 2nd stage storage in the form of electro-chemical battery. The preferred embodiment comprising:

a) An intermittent and variable energy source such as from an array of photovoltaic cells.

b) A 1st stage of soft storage such as high value capacitor as might be realized by an electrical double layer capacitor (also known as an Ultra capacitor or Supercapacitor).

c) Voltage sensing and control logic electronics which monitors the voltage, and thus the energy accumulated in the 1st stage of storage, and when the voltage is above a minimum threshold, connects the 1st stage of storage to the following electronics means.

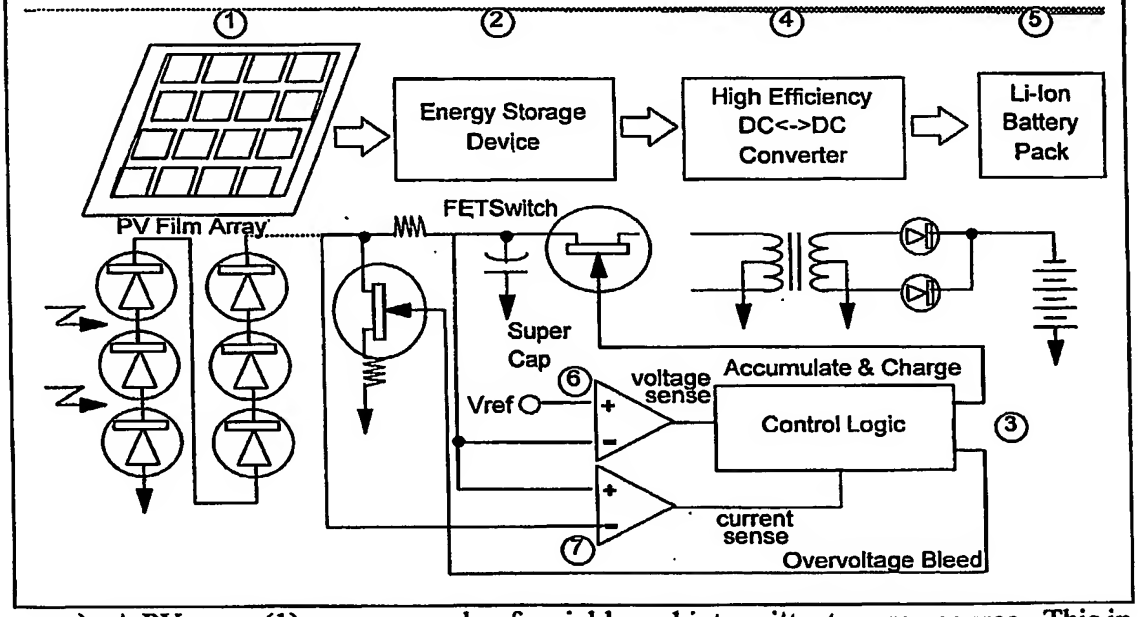
d) Suitable power regulation, transformation, and conditioning electronics in the form of a DC to DC converter to accept the energy in the 1st stage of storage and employ it to efficiently and safety charge a 2nd stage of storage.

e) A 2nd stage of storage such as a lithium-ion (Li-Ion)(or other chemistry of rechargeable) battery to accept the charging energy from the electronics.

DETAILED DESCRIPTION OF THE INVENTION

In figure 4, there is shown a

Figure 4; Overall Block Diagram of The Present Invention



a) A PV array (1) as an example of variable and intermittent energy source. This in turn is connected to,

b) A 1st stage energy storage means (2) such as supercapacitor. Said 1st stage energy storage means is referred to herein as soft storage to distinguish it from what we define as the hard storage properties of a typical battery. The essential properties of said 1st stage energy storage means are that it can accept and efficiently accumulate even low levels of energy from the energy source (1) without a threshold and without waste. The 1st stage energy storage means (2) is connected to both control logic (3) as well as a switchable DC to DC converter (4).

c) The control logic means (3) monitors the voltage level on the 1st stage energy storage means (2) and when the voltage sensor (6) recognizes that the voltage exceeds a preset threshold, it activates the switch and DC to DC converter means (4). In the preferred embodiment of the device, the control logic also provides means to protect the 1st stage energy storage means (2) from over-voltage conditions that might damage it by the use of 2nd switch to bleed excess energy and thereby limits the maximum voltage across the 1st stage energy storage means (2). Also part of the control logic is a current flow sensor (7). The current flow sensor can determine if the energy source is strong enough to source current into the energy storage means (2). Should the energy from the source cause the current flow to reverse thereby discharging the energy storage means (2); the current flow sensor (7) can signal the control logic (3) to make use of the energy in the storage means (2) even if the voltage is below the optimum threshold.

d) A 2nd stage of hard storage means (5) shown with a Li-Ion battery as an example. As used herein, we define hard storage as the energy storage device employed for long term storage with a capacity of significantly more energy (higher density) than the 1st stage soft storage means (2).

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WHAT IS CLAIMED IS:

1. An electronic device which captures and accumulates variable levels of electrical energy in suitable short term storage means until the energy is of such a level that it can be efficiently transferred to long term storage means, comprising:
   a) A source of variable and intermittent energy.
   b) 1st stage energy storage means suitable for efficiently capturing and accumulating the energy from the source.
   c) Electronic means which senses and monitors the energy accumulated in the 1^{st} stage storage means and then activating charge management electronics when there is sufficient energy in the 1^{st} stage storage to efficiently charge a 2^{nd} stage energy storage means
   d) A 2^{nd} stage means of energy storage, which accepts the charging energy from the electronic means and stores it for latter usage.
2. The means of claim 1 in combination with an electrical double layer capacitor as suitable means for 1^{st} stage storage.
3. The means of claim 1 in combination with a control circuit that senses an over-voltage condition in the 1^{st} stage storage means and limits the voltage to a safe level.
4. The means of claim 1 in combination with a control circuit that senses the direction of current "into" versus "out of", the 1^{st} stage storage means and activates the transfer of any useful energy from the 1^{st} stage storage means to the 2^{nd} stage storage means even if the voltage in the 1^{st} stage storage means is not optimal for such a transfer.
5. The means of claim 1 in combination with a photovoltaic cell or array of cells as the energy source means

6. An electronic device which captures and accumulates varying levels of electrical energy in suitable short term storage means until the energy is of such a level that it can be efficiently transferred to long term storage means, comprising:

a) A connector that allows an external energy source to be briefly connected to the device for the purpose of rapidly charging a 1st stage energy storage means (this could be in the form of an AC or DC transformer, step-up or step-down, with or without rectifiers).

b) A 1st stage energy storage means suitable for efficiently capturing and accumulating the energy from the source.

c) Electronic means which senses and monitors the energy accumulated in the 1st stage storage means and then activating charge management electronics when there is sufficient energy in the 1st stage storage to efficiently charge a 2nd stage energy storage means

d) A 2nd stage means of energy storage, which accepts the charging energy from the electronic means and stores it for latter usage.

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TITLE: A TWO STAGE ENERGY STORAGE DEVICE

INVENTOR: ANDREW C. KULAR

ABSTRACT OF DISCLOSURE

An electronic device, which captures and accumulates varying levels of electrical energy in suitable short-term storage means until the energy is of such a level that it can be efficiently transferred to long-term storage means.

VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS (37 CFR 1.9(f) AND 1.27 (c)) - SMALL BUSINESS CONCERN	Docket No. 5276-110P

Serial No.	Filing Date	Patent No.	Issue Date
HEREWITH	HEREWITH	HEREWITH	HEREWITH

Applicant/ Patentee: **Andrew C. Kular**

Invention: **A TWO STAGE ENERGY STORAGE DEVICE**

I hereby declare that I am:

- ☐ the owner of the small business concern identified below:
- ☒ an official of the small business concern empowered to act on behalf of the concern identified below:

NAME OF CONCERN: **ECOSOL Solar Technologies, Ltd.**

ADDRESS OF CONCERN: **7 Hinton Avenue N. Ottawa, Ontario, Canada K1Y 4P1**

I hereby declare that the above-identified small business concern qualifies as a small business concern as defined in 13 CFR 121.3-18, and reproduced in 37 CFR 1.9(d), for purposes of paying reduced fees under Section 41(a) and (b) of Title 35, United States Code, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

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NAME OF PERSON SIGNING: **Thomas J. Onka**

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